Photonic Crystal Based Optical Interconnects

Muhammad Umar Khan[1], John Justice[1], Arjen Boersma[2], Judith Wijnhoven[3] and Brian Corbett[1]

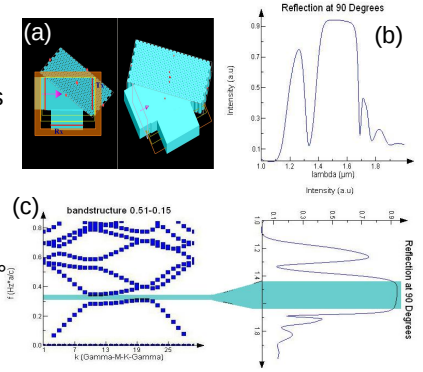
[1]Photonics centre, Tyndall National Institute, Lee Maltings, Prospect Row, Cork, Ireland.
[2]TNO, De Rondom 1 5612AP, Eindhoven, The Netherlands.
[3]Soft Condensed Matter, Ornstein Laboratory, Utrecht.

Motivation

Demands for high data transfer rates with improved latency and power per bit are the main challenges in modern computing systems. Copper based electrical interconnects are unable to meet these challenges, so optical interconnects are emerging as an alternate approach at various levels including chip-to-chip, board-to-board, board-to-backplane and rack-to-rack interconnects. We are investigating a chip-to-chip polymer based optical interconnect system with sharp bends which can be fabricated at industrial scale. We are investigating whether these sharp bends can be achieved using three dimensional photonic crystals.

Design of 2-D Photonic Crystal Reflectors

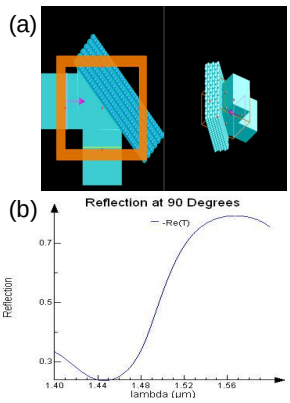
- Photonic crystals embedded in polymer waveguides
- 2-D core-shell rod structure
  - TiO_2 core
  - SiO_2 shell
- Photonic crystals angled at 45° for 90° bend
- Reflections at telecom (1550nm) wavelengths

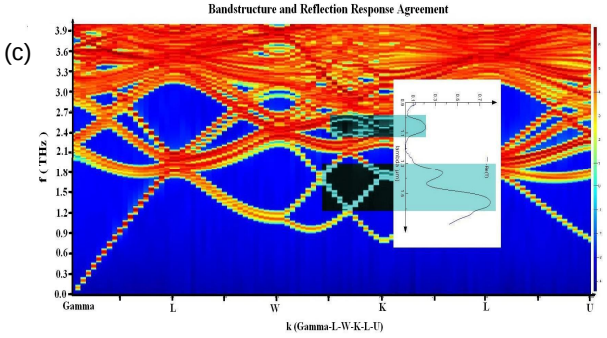


(a) Modelled core-shell structure with waveguides (b) Reflection response from the structure (c) An agreement between bandstructure and reflection response.

Design of 3-D Photonic Crystal Reflectors

- Polymer waveguide embedded structures.
- 3-D core-shell sphere structure
  - TiO2 core
  - SiO2 shell
- Face Centric Cubic (FCC) stacking
- Fabrication imperfections are simulated to predict the response from actual fabricated crystals.

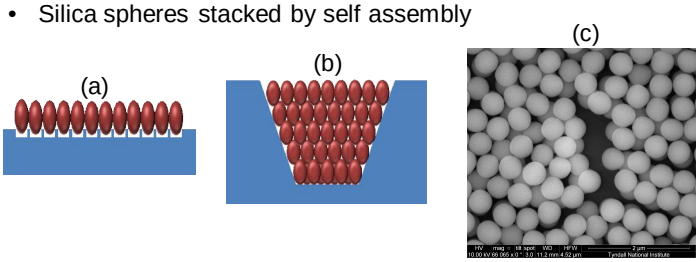




(a) Modelled FCC structure with waveguides (b) Reflection response from the structure (c) An agreement between bandstructure and reflection response.

Fabrication of Photonic crystal structures

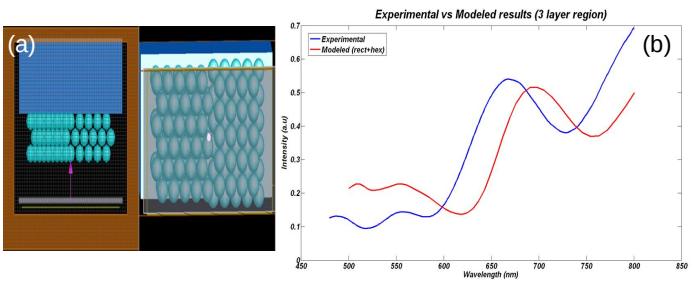
- Nanolithography for polymer waveguides fabrication
- Initially, silica sphere (without TiO_2 core) photonic crystals
- Silica spheres stacked by self assembly



(a) Single layer of spheres placed on seed layer (b) Photonic crystal formed by self assembly of the spheres (c) SEM image of the sample formed by self assembly of silica spheres.

Characterization of Silica Photonic crystals

- Initial samples had mix of hexagonal and cubic lattice
- Expected reflection response is simulated and experimentally observed



(a) Three layer modelled photonic crystal structure having mix of rectangular and hexagonal lattice. (b) Agreement between simulated and experimental results.

Summary

Good agreement is found between the simulated and experimentally observed responses. A seed layer on the underlying wafer will be used to make the stacking single phase. Following that a core-shell photonic crystal structure will be stacked using underlying seed layer as a route to achieve the goal of a compact 90 degree waveguide bend.

Acknowledgement

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